Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Chemistry 313

Chapter 3

**INTRODUCTION TO THE PERIODIC TABLE**

***Chapter Outline***

3.1 🡪 Development of the Modern Periodic Table

*Vocabulary*

|  |  |  |
| --- | --- | --- |
| periodicity | periodic law | triads |
| law of octaves |  |  |

*Objectives*

* **Outline** the steps in the historical development of the periodic table.
* **Predict** similarities in properties of the elements by using the periodic table.

3.2 🡪 Classification of the Elements

*Vocabulary*

|  |  |  |
| --- | --- | --- |
| period | group | noble gas |
| metal | transition element | lanthanide |
| actinide | nonmetal | metalloid |
| semiconductor | representative element | alkali metal |
| alkaline earth metal | transition metal | inner transition metal |
| halogen | noble gas |  |

*Objectives*

* **Identify** key features of the periodic table.
* **Use** the periodic table to classify an element as a metal, nonmetal, or metalloid.
* **Compare** the properties of metals, nonmetals, and metalloids.

3.3 🡪 Periodic Trends

*Vocabulary*

|  |  |  |
| --- | --- | --- |
| electronegativity | ion | octet rule |

*Objectives*

* **Relate** an element’s valence electron structure to its position in the periodic table.
* **Compare** period and group trends of several properties.

**Vocabulary**

|  |  |
| --- | --- |
| **Terms** | **Definitions** |
| periodicity |  |
| law of octaves |  |
| periodic law |  |
| triads |  |
| period |  |
| metal |  |
| actinide |  |
| semiconductor |  |
| alkaline earth metal |  |
| halogen |  |
| group |  |
| transition element |  |
| nonmetal |  |
| representative element |  |
| transition metal |  |
| noble gas |  |
| lanthanide |  |
| metalloid |  |
| alkali metal |  |
| inner transition metal |  |
| electronegativity |  |
| ion |  |
| octet rule |  |

**INTRODUCTION TO THE PERIODIC TABLE**

***Chapter Notes Outline***

**Warm-up #1:** What is an octave?

**Slide 3: Development of the Modern Periodic Table**

The Search for a Periodic Table

* Chemists wanted to organize the elements into a system that would show

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ while \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ was used as the basis.
* J.W. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1829)
* Classified some elements with similar properties into groups of three called

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Their properties varied in an orderly way according to their atomic masses.
* John \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1864)
* Created the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, which stated that the properties of the elements repeated every eighth element

**Slide 4: Development of the Modern Periodic Table**

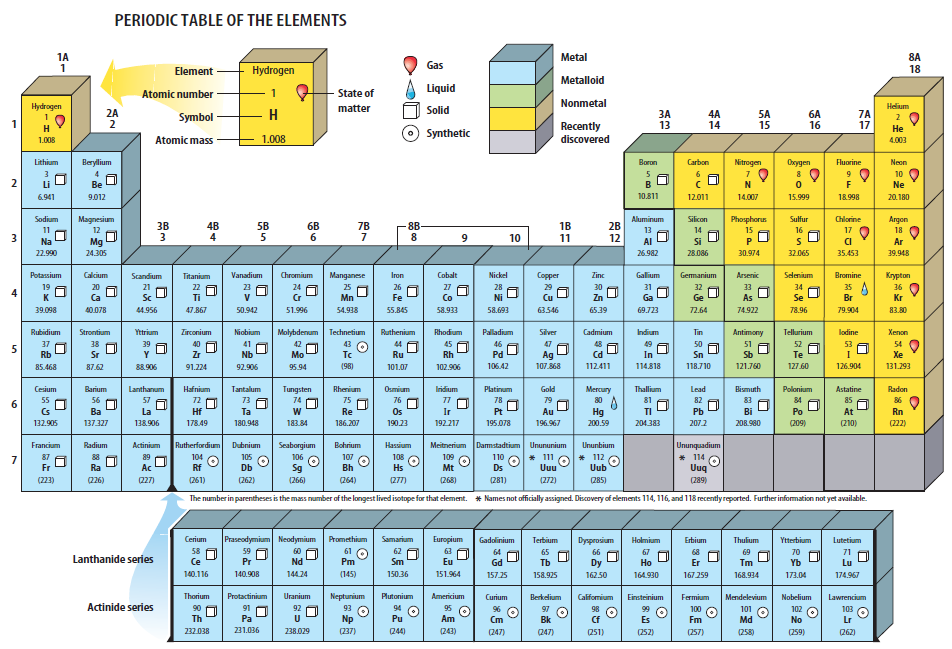
* Dmitri \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1869)
* Arranged the elements in order of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ into

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Predicted the existence and properties of undiscovered elements
* Showed that the properties of the elements repeat in an orderly way from row to row of the table
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the tendency to recur at regular intervals.
* Henry \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (1913)
* Discovered that atoms of each element contain a unique number of protons in their nuclei (=atomic number)
* Arranged the elements in order of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to show a clear periodic pattern of properties
* The statement that the physical and chemical properties of the elements repeat in a regular pattern when they are arranged in order of increasing

atomic number is known as the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Slide 5: The Modern Periodic Table**



**Exit Question #1:** What does the game “Battleship” have in common with the modern periodic table?

**Warm up Question #2:** What the following objects all have in common?

**Slide 8: Organization of the Table**

The Modern Periodic Table…

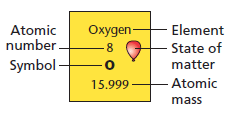
* Elements are arranged in order of increasing atomic number into a series of columns,

called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (or families), and rows, called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

* The groups designated with an “A” are often referred to as the main group, or

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

* The groups designated with a “B” are referred to as the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.



**Slide 9: Classification of the Elements - Metals**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are elements that are generally shiny when smooth and clean, solid at room temperature, and good conductors of heat and electricity.

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_elements (except for hydrogen) are known as the \_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ elements are known as the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ elements (transition elements) are divided into \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Slide 10: Properties of Metals**



**Slide 11: Classification of the Elements – Non-Metals**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are elements that

are generally gases or brittle, dull-looking

solids, and poor conductors of heat and

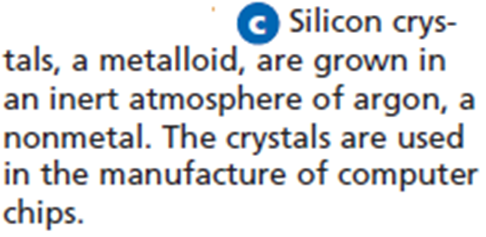
electricity.

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ elements are known as

the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ elements are known as

the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Slide 12: Classification of the Elements – Metalloids**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are elements with

physical and chemical properties of both

metals and nonmetals.

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Warm up Question #3:** Which one comes up next in the sequence?

**Exit Question #2:** Why is the last group of the periodic table known as the noble gases?

**Slide 15: Periodic Trends – Atomic Radius**

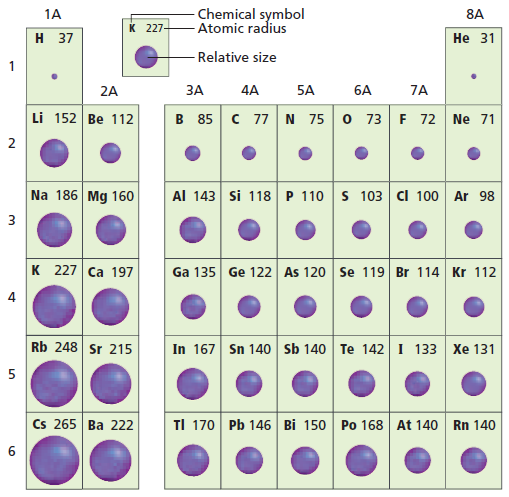
Atomic Radius…

* Trends within periods
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

atomic radii as you move \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

across a period

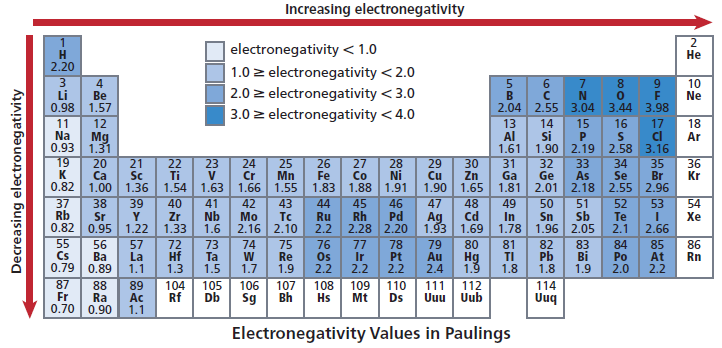
* Trends within groups
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in atomic radii as you move \_\_\_\_\_\_\_\_\_\_ a group



**Slide 16: Periodic Trends – Electronegativity**

Electronegativity…

* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of an element indicates the relative ability of its atoms to attract electrons in a chemical bond.
* Trend within periods
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as you move \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ across a period
* Trend within groups
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as you move \_\_\_\_\_\_\_\_\_\_ a group



**Slide 17: Periodic Trends – Valence Electrons**

Valence Electrons…

* Atoms in the same group have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because they

have the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of an atom’s valence electrons indicate the

\_\_\_\_\_\_\_\_\_\_ in which it is found.

* A representative element’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_ it contains are equal (with a few exceptions).

* Atoms can gain or lose one or more electrons and acquire a net charge.
* An \_\_\_\_\_\_\_\_\_\_ is an atom or a bonded group of atoms that has a positive or negative charge.
* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ states that atoms tend to gain, lose, or share

electrons in order to acquire a full set of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Exit Question #3:** Why do you think that the size of the atom increases as you go from the top of the periodic table to the bottom of the table?

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**HOMEWORK #1**

1. **Define the following terms in the vocabulary section of your packet:**

Periodicity, periodic law, triads and law of octaves

1. What is the modern periodic law? How does it differ from Mendeleev’s periodic law?
2. What are 2 factors that contributed to the widespread acceptance of Mendeleev’s periodic table?
3. Which of Dobereiner’s triads shown are still listed in the same column of the modern periodic table?

|  |  |  |
| --- | --- | --- |
| *Triad 1* | *Triad 2* | *Triad 3* |
| lithium (Li) | manganese (Mn) | sulfur (S) |
| sodium (Na) | chromium (Cr) | selenium (Se) |
| potassium (K) | iron (Fe) | tellurium (Te) |

1. Use the periodic table to separate these 12 elements into 6 pairs of elements having similar properties.

*Ca, K, Ga, P, Si, Rb, B, Sr, Sn, Cl, Bi, Br*

1. Use the periodic table to identify by name and symbol the elements that have the following atomic masses:

1. 30.974 amu \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_
2. 137.327 amu \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_
3. 18.998 amu \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_
4. 118.710 amu \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_

**HOMEWORK #2**

1. **Define the following terms in the vocabulary section of your packet:**

|  |  |  |
| --- | --- | --- |
| period | group | noble gas |
| metal | transition element | lanthanide |
| actinide | nonmetal | metalloid |
| semiconductor | representative element | alkali metal |
| alkaline earth metal | transition metal | inner transition metal |
| halogen | noble gas |  |

1. Describe element number 18 in terms of its period number, group number, and family name.
2. What is the group number of each of the following families of elements? Write the symbols for the elements in each family.

1. alkali metals \_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. halogens \_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. alkaline earth metals \_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. noble gases \_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Select the symbol of the element that fits the following descriptions.
6. the group 13 metal in the 3rd period \_\_\_
7. the group 15 metalloid in the 4th period \_\_\_
8. the lightest of the noble gases \_\_\_
9. the halogen that exists as a liquid at room temperature \_\_\_
10. the only metal that is a liquid at room temperature \_\_\_

**HOMEWORK #3**

1. **Define the following terms in the vocab section of your packet:**

Electronegativity, ion and octet rule

1. How many valence electrons are in an atom of each of the following elements, and what ion would each atom form?

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| a. | Ne |  |  |  | e. | Br |  |  |
| b. | S |  |  |  | f. | Sr |  |  |
| c. | Na |  |  |  | g. | As |  |  |
| d. | Sn |  |  |  | h. | In |  |  |

1. Write > (greater than) or < (less than) to indicate how the electronegativities of the following elements compare. 6 POINTS

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| a. | Cl |  | F | e. | Mg |  | Ca |
| b. | C |  | N | f. | Bi |  | P |
| c. | Kr |  | Ar | g. | Ca |  | K |

**End of Homework**

The Development of the Periodic Table

[**Johann Wolfgang Döbereiner**](http://en.wikipedia.org/wiki/Johann_Wolfgang_D%C3%B6bereiner)

Taken from: http://en.wikipedia.org/wiki/D%C3%B6bereiner's\_triads

In the [history of the periodic table](http://en.wikipedia.org/wiki/History_of_the_periodic_table), **Döbereiner's triads** were an early attempt at organizing the [chemical elements](http://en.wikipedia.org/wiki/Chemical_elements) by certain physical properties. In 1829, the German chemist [Johann Wolfgang Döbereiner](http://en.wikipedia.org/wiki/Johann_Wolfgang_D%C3%B6bereiner) pointed out that there were [triads](http://en.wikipedia.org/wiki/Triad) of elements that showed similar chemical properties. He also noticed the fact that the atomic weight of the central element of the triad approximately the average of the atomic weights of the other two members. The properties of the middle element were in between those of the end members

***Based on atomic mass alone, try to determine which of the elements in the list below belong in the missing spots in each of Dobereiner’s triads.***

|  |  |  |
| --- | --- | --- |
| Oxygen 16.0 | Chlorine 35.5 | Selenium 79.0 |
| Calcium 40.0 | Sodium 23.0 |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Element 1 Atomic mass** | **Element 2 Atomic mass** | **Element 3 Atomic mass** |
|  | Triad #1 | [Lithium](http://en.wikipedia.org/wiki/Lithium) 7.0 |  | [Potassium](http://en.wikipedia.org/wiki/Potassium) 39.0 |
|  | Triad #2 |  | [Strontium](http://en.wikipedia.org/wiki/Strontium) 87.5 | [Barium](http://en.wikipedia.org/wiki/Barium) 137.0 |
|  | Triad #3 |  | [Bromine](http://en.wikipedia.org/wiki/Bromine) 80.0 | [Iodine](http://en.wikipedia.org/wiki/Iodine) 127.0 |
|  | Triad #4 | [Sulfur](http://en.wikipedia.org/wiki/Sulfur) 33.0 |  | [Tellurium](http://en.wikipedia.org/wiki/Tellurium) 128.0 |
|  | Triad #5 | [Carbon](http://en.wikipedia.org/wiki/Carbon) 12.0 | [Nitrogen](http://en.wikipedia.org/wiki/Nitrogen) 14.0 |  |
|  |

**John Newlands**

The similarity between Newland’s table and the modern periodic table is that elements are arranged according to their chemical properties. In the modern table, elements with similar properties can be found in the same group The difference between the two tables is that like Dobereiner, Newland’s table was also arranged according to atomic mass whereas the modern periodic table is not.

***Below is an example of the law of octaves. Using the modern periodic table to locate members of the same group (same chemical properties), fill in octave chart.***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| H | Li | Be | B |  | N | O |  |  | Mg |  | Si | P |  | Cl |

**Classification and Properties of Elements**

Fill in the following table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Element | Symbol | Group | Period | Family |
| Mercury |  |  |  |  |
|  |  | 13 |  | Metalloid |
|  | K |  |  |  |
|  |  | 18 | 4 | Noble Gas |
| Lead |  |  |  |  |
|  | U | X |  |  |
|  |  | 17 | 3 |  |
| Lutetium |  |  |  |  |
|  | Ra |  |  |  |
|  |  | 14 |  | Nonmetal |

Metals, Non-Metals and Metalloids

Identify each of the following as metal, non-metal or metalloid. Also identify each as a representative group element or transition element.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Metal | Non-metal | Metalloid | Representative | Transition |
| Oxygen (O) |  |  |  |  |  |
| Barium (Ba) |  |  |  |  |  |
| Germanium (Ge) |  |  |  |  |  |
| Iron (Fe) |  |  |  |  |  |
| Neon (Ne) |  |  |  |  |  |
| Praseodynium (Pr) |  |  |  |  |  |

Which of the following elements are likely to conduct electricity? (Circle all that apply)

Cl Sr Li Ar Sn C Br Cu

Which of the following are likely to be brittle solids or gases at room temperature? (Circle all that apply)

Cl Sr Si Li Ar Sn C Br

The description applies to a metal, a nonmetal, or a metalloid. Write the correct letter in the space provided. Letters can be used more than once.

1. are malleable

a. metalloids

b. nonmetals

c. metals

2. are dull or shiny

3. are poor conductors

4. tend to be brittle and unmalleable as solids

5. are almost always shiny

6. are also called semimetals

7. are almost always dull

8. are somewhat ductile

9. include boron, silicon, antimony

10. include lead, tin, copper

11. include sulfur, iodine, neon

**Periodic Trends**

1. Which atom in each pair has the **larger** atomic radius?

a) O or C b) Be or Ba

2. Which atom in each pair has the **larger** electronegativity?

a) Al or Si b) Na or K c) O or P

1. Consider atoms of the following, which are located as shown in the Periodic Table:

S Cl Se Br

a) Which has the **highest** electronegativity?

c) Which has the **smallest** atomic radius?